Hot flash report and measurement among Bangladeshi migrants, their London neighbors, and their community of origin

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Pages: 25 pages text, 6 pages bibliography, 1 figure, 6 tables

Abbreviated title: Hot flashes among Bangladeshi migrants

Keywords: menopause, ambient temperature, activity

Supported by: NSF grant #0548393, Commonwealth Scholarship and Fellowship Plan (CSFP, UK), Sigma Xi, and the Wolfson Research Institute, Durham University.

Abstract:

Objectives: To examine hot flashes in relation to climate and activity patterns, and to compare subjective and objective hot flashes among Bangladeshi immigrants to London, their white London neighbors, and women still living in their community of origin, Sylhet, Bangladesh ("sedentees").

Methods: Ninety-five women, aged 40-55, wore the Biolog ambulatory hot flash monitor. Objective measurements and subjective hot flash reports were examined in relation to demographic, reproductive, anthropometric, and lifestyle variables; temperature and humidity at 12:00 and 18:00; and time spent on housework and cooking. Concordance of objective and subjective hot flashes was assessed by Kappa statistics and by sensitivity of hot flash classification.

Results: During the study period, Bangladeshi sedentees reported more subjective hot flashes ($p<0.05$), but there was no difference in number of objective hot flashes. White Londoners were more likely to describe hot flashes on their face and neck compared to Bangladeshis ($p<0.05$). Sedentees were more likely to describe hot flashes on their feet ($p<0.05$). Post-menopausal status, increasing parity, and high levels of housework were significant determinants of subjective hot flashes, while ambient temperature and humidity were not. Measures of subjective/objective concordance were low but similar across groups (10% to 20%). The proportion of objective hot flashes that were also self-reported was lowest among immigrants.

Discussion: Hot flashes were not associated with warmer temperatures, but were associated with housework and with site-specific patterns of cooking. The number of objective hot flash measures did not differ, but differences in subjective experience suggest the influence of culture.

Introduction

Hot flashes are a common event experienced during the menopausal transition by up to 80% of women in the U.S. and Britain (Gold et al. 2006; Hunter et al. 2012), and can last up to 10 years or longer (Avis et al. 2015; Col et al. 2009; Hunter et al. 2012; Politi et al. 2008; Warren 2009). Hot flashes can be uncomfortable and embarrassing (Reynolds 1997), interfere with sleep (Freedman and Roehrs 2006; Woods and Mitchell 2010), impair quality of life (Avis et al. 2009), and may serve as a marker for risk of chronic disease (Brown et al. 2011; Szmuilowicz et al. 2011; Thurston et al. 2008).

Hot flashes are a heat dissipation response involving both vasodilation and sweating (Casper and Yen 1985; Freedman 2001; Sievert 2007) due to altered hypothalamic thermoregulation (Archer et al. 2011; Stearns et al. 2002; Santoro 2008). External application of heating pads to the central body, strenuous exercise, and warm ambient temperatures in the laboratory have been shown to provoke hot flashes (Freedman 1989; Freedman and Krell 1999; Freedman and Roehrs 2006; Kronenberg and Barnard 1992; Sievert et al. 2002). Outside of the laboratory, a survey of hot flash frequencies gathered by a variety of methods in 54 countries found that hot flash report (yes/no) was negatively correlated with the temperature of the coldest month of the year. Women were less likely to report hot flashes in warmer, tropical climates. Difference in temperature between the hottest and coldest months (seasonality) was also a significant predictor, so that women living in seasonal climates reported more hot flashes (Sievert and Flanagan 2005). In a study of hot flashes in Spain and 3 countries in South America, temperature and humidity were not associated with hot flash report (yes/no) after controlling for other variables. On the other hand, temperature and humidity were positively associated with hot flash frequency (the number of hot flashes/night sweats experienced in the

previous week) and problem-rating (hot flashes as problematic on 10-point scale) (Hunter et al. 2013).

Hot flashes have been associated with low or variable estradiol levels, low levels of inhibin B and anti-Müllerian hormone, and high levels of follicle stimulating hormone (Dhanoya et al. 2016; Freeman et al. 2009; Guthrie et al. 2005). However, these hormonal changes are experienced by all women at midlife, not just women with hot flashes. Differences in hot flash report may reflect variation in genes involved in estrogen metabolism (Butts et al. 2012, Crandall et al 2006; Rebbeck et al. 2010; Schilling et al 2007); however, the etiology of hot flashes is most likely associated with a narrowing of the thermoneutral zone that makes it easier to trigger heat dissipation by vasodilation and sweating (Archer et al. 2011; Freedman 2002; Freedman and Krell 1999).

Cross-cultural reviews have established variation in hot flash frequencies across countries and across ethnic groups within the same country (Freeman and Sherif 2007; Lock 2005; Melby et al. 2005, 2011; Obermeyer 2000; Sievert 2006). The likelihood of hot flashes increases with peri- or postmenopausal status (Gold et al. 2006; Guthrie et al. 2005; Melby et al. 2011), smoking (Butts et al. 2012; Gjelsvik et al. 2011; Guthrie et al. 2005; Whiteman et al 2003), and lower levels of education (Brambilla and McKinlay 1989; Gold et al. 2006). Active women may experience fewer hot flashes than inactive women (Guthrie et al. 2005; Ivarsson et al. 1998); however, exercise has also been associated with increased hot flash frequencies (Aiello et al. 2004; Elavsky and McAuley 2007; Freedman and Krell 1999; Whitcomb et al. 2007). In a study of symptoms among women in Sylhet, Bangladesh, the likelihood of reporting hot flashes increased with time spent doing housework and cooking (Sharmeen et al. 2013). Among

Muslims in Sylhet, the timing of hot flashes appeared to be influenced by the physical activity associated with Islamic prayer, as well as culture-specific clothing (Sievert et al. 2008).

A high body mass index (BMI) has been associated with a greater likelihood of hot flashes in some (Gold et al. 2006; Whiteman et al. 2003), but not all (Gallicchio et al. 2014; Gjelsvik et al. 2011) studies, perhaps related to the stage of the menopausal transition (Thurston et al. 2013). A high BMI may be associated with a layer of insulation that narrows the thermoneutral zone and makes it easier for hot flashes to be triggered (Freedman 2002), or otherwise reduces the effectiveness of the body's ability to dissipate heat. High adiposity may also play an endocrine role in hot flashes through the aromatization of androgens to estrogens (Bulun et al. 1999). Differences in hot flash frequencies may also reflect variation in household and sociocultural environments (Gupta et al. 2006; Lock 1998; Melby et al. 2005; Sharmeen et al. 2013).

To complement information gained from the subjective report of hot flashes through questionnaires, hot flashes can be measured with an ambulatory monitor (Carpenter et al. 1999; Sievert 2013; Thurston et al. 2005). Electrodes are applied to the upper chest, and the ambulatory monitor records changes in sweating because electricity travels faster across a moist surface. Sweating due to hot flashes can be differentiated from sweating due to ambient heat or exercise by specific criteria applied to changes in the level of skin conductance of electricity (Freedman 1989). The monitor does not measure change in skin temperature.

In a study of hot flashes in Sylhet, Bangladesh, Muslim participants had more objective hot flashes per woman than Hindu participants. In addition, Muslims were more likely to demonstrate objective hot flashes that they did not feel (Sievert et al. 2008).

The purpose of this study was examine objective and subjective hot flash experience among Bangladeshi sedentees, Bangladeshi immigrants living in London, and their white British

neighbors living in very different climatic and sociocultural environments: London, U.K. and Sylhet, Bangladesh. Participants were women who were: (a) born in Bangladesh and migrated to London, (b) their white London neighbors, and (c) women living in their community of origin, Sylhet, Bangladesh ("sedentees"). Objective and subjective hot flashes were measured in relation both to temperature and humidity on the days that hot flashes were measured as well as to everyday activities such as cooking and household work that can elevate core body temperature. Thus, we measured hot flashes in the ambient temperature and humidity to which women had become accustomed (although, in the case of migrants, not necessarily the temperature and humidity in which they grew up) and in relation to measures of household work and cooking activity during the past week.

Based on the cross-population negative correlation between temperature and hot flashes (Sievert and Flanagan 2005), we hypothesized a greater likelihood of *subjective*, self-reported hot flashes in association with the temperate climate of London. Based on the ability to trigger hot flashes with heat and activity (Freedman 1989; Freedman and Krell 1999), we hypothesized a greater likelihood of *objective* hot flashes in Sylhet, Bangladesh. In light of the lack of concordance previously measured between objective and subjective measures of hot flashes in Sylhet (Sievert et al. 2008), we hypothesized a higher level of concordance among white Londoners in the temperate climate of London compared to Bangladeshi immigrants and sedentees. We also hypothesized that women undertaking more cooking and household activities would be more likely to experience hot flashes than those with lighter household duties.

METHODS

This comparison of hot flash experience was part of a study of reproductive aging and symptoms at midlife carried out in Sylhet and London from March, 2007, to May, 2010, among Bangladeshi immigrants (adult migrants n=174, child migrants n=49), their London neighbors of European origin (n=154), and Bangladeshi sedentees (n=157) (Murphy et al. 2013). A subset of immigrants (n=35), London neighbors (n=30), and sedentees (n=30) wore ambulatory hot flash monitors.

Bangladeshi sedentees were drawn from the northeastern city of Sylhet because the majority of Bangladeshi immigrants to London originate from the region of Sylhet (Eade, 1994). Only middle and upper-middle class Bangladeshi women with the means to emigrate were included in the study for comparison with immigrants in London (Sievert et al. 2008). Women in Sylhet were recruited by word of mouth with the help of influential community members and 9 undergraduate students from Shahjalal University.

All data were collected in Bangladesh during March and April of 2007, neither the hottest nor coolest time of the year and just prior to the monsoon season when conditions are relatively dry. In London, Bangladeshi migrants were recruited from community centers with the help of local contacts, and through advertisements in free local papers in boroughs where migrants reside. The majority of participants came from the borough of Camden. Almost all interviews and anthropometric measures of Bangladeshi participants in Sylhet and in London were carried out in Bangla (the national language of Bangladesh) or Sylheti (the local dialect in Sylhet) by two of the authors (K.B. and T.S.). Bangladeshi migrant women who wore the monitors were recruited

during 2007 and 2008. The majority of these women wore the monitor in the summer (63%), 23% in the winter, and 14% in the fall.

London women of European origin were recruited through word of mouth and the use of posters in libraries, doctors' offices, community centers, subway stations and market places, and through advertisements in free local papers. Women who wore the monitors were recruited in 2007, 2008, and 2009, with 53% wearing the monitor in the winter and 47% wearing the monitor in the summer. Most of the interviews and measurements in London were carried out by L.M.

All women were screened for eligibility via initial face-to-face or telephone interviews, or by email. Eligibility requirements included no use of exogenous hormones in the past 3 months, not pregnant or lactating, and no history of hysterectomy, oophorectomy, or thyroid problems. In addition, women of European origin were required to have parents born in the UK or Ireland. The subset of women who wore the hot flash monitors were aged 40 to 55. This age range was chosen because of the relatively early age at menopause in Sylhet, Bangladesh (Murphy et al. 2013). Women were invited to wear the hot flash monitors whether they reported hot flashes or not. Ethical approval was obtained from the Institutional Review Boards of UMass Amherst, and Ethics Committees at University College London, Durham University, and the M.A.G. Osmani Medical College, Sylhet, Bangladesh.

Women were questioned about their age, birthplace (rural/urban), education, financial comfort (struggling/OK/comfortable/well off), marital status, migration history (migrant/sedentee and years in UK), religion (Hindu/Muslim), tobacco use (smoking or with betel quid), reproductive history, life stresses, and history of infectious/parasitic diseases (Murphy et al. 2013). Menopausal status was categorized as pre-menopausal (regular menstruation, or small changes in frequency or amount of bleeding), peri-menopausal (irregular

menstruation, or missing entire months of menstruation), and post-menopausal (no menstruation for 12 months or more.) Household workloads were computed as minutes per day spent in an activity multiplied by the number of times per week the activity was performed. Workloads were categorized as "housework" (mopping, dusting, cleaning the bathroom, and washing clothes by hand) and "cooking" (Sharmeen et al. 2013). Height, weight, waist and hip circumferences were also measured. Qualitative aspects about menopause were explored using open-ended questions as well as by asking women to state terms they would use to describe the menopausal transition.

Forty percent of the Bangladeshi women did not know their date of birth; therefore we estimated age at interview for these women using a calendar of political events, such as the India-Pakistan War, the Civil War with Pakistan and Bangladeshi Independence, and major environmental catastrophes, such as cyclones, floods, and tidal waves (FAO-UN 2008).

The symptom list was developed from a validated checklist used in many countries (Avis et al. 1993; Dennerstein et al. 1993; Obermeyer et al. 2007). Hot flashes and other symptoms associated with menopause were embedded into a list of 26 everyday complaints to reduce the likelihood that responses would conform to stereotypes about menopause. Seven additional menstrual, urinary, and sexual symptoms were queried toward the end of the questionnaire. For all symptoms, women were asked, "Thinking back over the past two weeks, have you ever been bothered by any of the following?" For each symptom women were asked to indicate "Not at all," "A little," "Quite a bit," or "Extremely". For Bangladeshi women, hot flashes were translated as "*gorom vap laga*" (feeling steaming hot).

In addition to hot flashes during the past two weeks, women were asked if they had <u>ever</u> experienced a hot flash. A list of 14 adjectives was provided to assess the sensations associated

with a hot flash: heat, burning sensation, sweating, flushed, pressure in head, pressure in chest, change in heart rate, change in breathing rate, anxiety, feel ill/nauseous, chills/clamminess, embarrassed, depressed, suicidal (Kronenberg 1990). Finally, women who experienced hot flashes were asked to describe where on the body the hot flashes started and how the feeling moved across the body using a body diagram (Sievert 2013; Voda 1997).

Objective hot flashes were assessed by sternal skin conductance using a Biolog ambulatory hot flash monitor (1081-HFD, UFI, Morro Bay, CA) worn from late morning to early evening. This time frame was chosen because of studies demonstrating a diurnal peak in hot flash occurrence in late afternoon (Carpenter et al. 2001; Freedman et al. 1995; Sievert et al. 2010). Two Ag/AgCl electrodes filled with 0.05 M potassium chloride Velvachol/glycol gel (Custom Med Apothecary, Indianapolis, IN) were placed about 4 inches apart on the upper chest. The electrodes conducted a 0.5 V constant-volt circuit and were attached by leads to the Biolog monitor where skin conductance was recorded. An objective hot flash was determined as an increase of 2 micromho within 30 seconds (Freedman 1989; Carpenter et al. 1999). Subjective hot flashes were recorded by pushing 2 buttons on the hot flash monitor.

Women who wore the monitor were compared with those who did not in order to assess how individuals may have self-selected to participate in objective measures of hot flashes. Among women who wore the monitor, sample characteristics were compared across the three groups (Bangladeshi sedentees, Bangladeshi migrants, and white London neighbors) by ANOVA or chi-square tests as appropriate. Mean ambient temperature and mean ambient humidity on the days when monitors were worn were provided by the Central Climate Unit of the Met Office, UK (http://www.metoffice.gov.uk/research/people/r-barry-hall). The timing of the temperature measures (12:00 and 18:00) matched the time period during which women wore the monitors.

Temperature and humidity were compared by ANOVA across the three groups. Not all temperature and humidity measurements were available for women living in London.
Hot flashes during the past two weeks (none, a little, quite a bit, extreme) were compared across the three groups by chi-square analysis, as were the reports of ever experiencing a hot flash and the frequency of hot flashes (e.g., once/month or once/day). Hot flash severity and frequency were examined by Pearson correlation analysis in relation to temperature and humidity measures. Hot flashes during the study period were examined for all women, and separately within each group, in relation to time spent on housework (dichotomized to below and above the median for the total and for each group) and time spent cooking (dichotomized in the same way.) In order to evaluate whether these relationships varied across the three groups, the Breslow-Day test was utilized. For these tests, a p-value less than 0.05 was used to indicate statistically significant group differences.

Across all groups (n=95), objective hot flashes (yes/no) and subjective hot flashes (yes/not) were examined in relation to age, level of education (low, medium, high), financial comfort, marital status (married or not married at time of interview), parity, exercise (yes/no), use of alcohol (yes/no), menopausal status (pre, peri, or post), BMI, waist circumference, having hot flashes on the upper chest (where the electrodes were placed), housework (high/low), cooking (high/low), smoking (among white Londoners only), age at immigration and years in London (among immigrants only), and use of betel nut and religion (among Bangladeshis only), as well as ambient temperature and humidity on the day of measurement, by chi-square analyses for categorical data and ANOVA analyses with *post hoc* tests for continuous data. Variables that approached significance in univariate analyses ($p<0.2$) were included in binary logistic

regression analyses (odds ratios with 95% CIs reported) to identify determinants of subjective and objective hot flashes during the study period.

In order to compare subjective (button pushes) and objective (Biolog) classification of hot flashes, the number of 20-minute segments in which no hot flash was recorded or reported was determined in addition to the number of subjective and objective hot flashes. Overall concordance of the objective and subjective approaches was assessed in two ways: 1. Kappa statistics were calculated to represent agreement in hot flash classification beyond chance alone; and 2. agreement of the objective and subjective methods was assessed only when hot flashes were observed by one or both approaches (i.e., after excluding intervals where no hot flashes were observed by either method). In addition, sensitivity of objective hot flash classification was determined -- considering subjective experience as the gold standard -- as the proportion of subjectively reported hot flashes that were similarly classified objectively. Secondarily, sensitivity of self-reported hot flashes was determined, with objective hot flashes considered as the gold standard, as the proportion of objectively classified hot flashes that were also self-reported.

RESULTS

Sample characteristics

Sample characteristics are shown in **Table 1** for both the larger sample (all groups combined, n=534) and the subsample of women who wore the hot flash monitor (n=95). In comparison to women who did not wear the monitor (n=439), women who wore the monitor were older (47.7 vs. 46.0 years, p=0.01) and more likely to be peri-menopausal (12% vs. 7%, p=0.05). Women who wore the monitor were also more likely to report hot flashes during the

past two weeks (63% vs. 33%, $p<0.01$), and more likely to report ever having had a hot flash (68% vs. 42%, $p<0.01$). In other words, it appears that symptomatic women were more willing to wear the monitor. The following comparisons are among the women who wore the monitor.

[Tables 1 goes about here.]

Among the Bangladeshi immigrants, 33 came to London as adults and two came to London as children. Immigrants tended to be pre-menopausal (66%) compared to sedentees (37%) or the white London neighbors (35%) ($p=0.08$). The white London neighbors were significantly older than the immigrant and sedentee Bangladeshis ($p<0.01$). Bangladeshi women, in both Sylhet and London, were more likely to be married ($p<0.01$), were less educated ($p<0.01$), less likely to exercise ($p<0.01$), and had greater waist circumferences ($p<0.05$), but not greater BMI, compared to white London residents. All Bangladeshi immigrants were Muslim, while 73% of the sedentees were Muslim and 27% were Hindu (**Table 1**).

Report of hot flashes

Sedentees were most likely to report having experienced hot flashes during the past two weeks (n=30; 73%), compared to Bangladeshi immigrants living in London (n=35; 63%) and white London neighbors (n=29; 55%), statistical trend $p<0.1$. The direction of the relationship was consistent with the larger study sample in which sedentees were more likely to report having experienced hot flashes during the past two weeks (n=156; 46%) compared to Bangladeshi immigrants living in London (n=222; 38%) and white London neighbors (n=153; 32%; $p=0.05$). Bangladeshi women tended to be more likely to describe hot flashes as "extreme" (23% of sedentees and 31% of migrants compared to 3% of white London neighbors, $p=0.09$), and tended to be more likely to report hot flashes more than 5 times per day (23% of sedentees, 21% of

migrants, compared to 9% of white London neighbors, p=0.07, **Table 2**). There was no difference across the three groups in the likelihood that they had ever experienced hot flashes, nor was there much difference across the three groups in the adjectives chosen to describe what hot flashes felt like. The only difference was that Bangladeshis were more likely to describe hot flashes as a "burning sensation" compared to white Londoners. Across all sites, only 7 women (8%) reported night sweats without hot flashes.

[Table 2 goes about here]

Women in all sites were most likely to report hot flashes on their upper chest. White London neighbors were more likely to describe hot flashes on their face (p=0.05) and the front of their neck (p<0.05) compared to Bangladeshis, and less likely to describe hot flashes on their back (p<0.05). Sedentees were more likely to describe hot flashes on their feet (p<0.05) compared to the other groups (**Figure 1**).

[Figure 1 goes about here.]

Hot flashes during the study period

Most women wore the monitors from 11:00 to 19:00; therefore the frequencies of hot flashes were calculated during that time period. Sedentees reported the most subjective hot flashes (mean 3.0) compared to Bangladeshi immigrants (mean 1.3) and their white neighbors (mean 1.2, p<0.05) (**Table 3**) by button pushes on the monitor. There were no significant differences in the frequency of objective hot flashes across the groups.

[Table 3 goes about here.]

Determinants of hot flashes

Menopausal status and parity were associated with subjective hot flash report in univariate tests of relationships between subjective hot flashes (yes/no) and demographic, reproductive, and lifestyle variables. Pre-menopausal women were less likely to report hot flashes compared to peri- and post-menopausal women (29% vs. 55% and 71%, $p<0.01$). Women with subjective hot flashes reported having more children compared to women without hot flashes (3.6 vs. 2.8 children, $p<0.05$). Among migrants, hot flash report was not significantly associated with age at immigration. Subjective hot flashes (yes/no) were not significantly associated with ambient temperature or humidity measurements. The self-reported frequency of hot flashes (e.g., 1/day or 1/week) was positively correlated with temperature at 12:00 ($r=0.38$, $p<0.05$), and tended to be correlated with temperature at 18:00 ($r=0.32$, $p=.08$); however, the frequency of hot flashes was not correlated with humidity at either time.

For the entire sample, there were no significant relationships between time spent in housework or cooking during the past week and the occurrence of subjective or objective hot flashes during the study period. The relationship between time spent cooking and hot flashes within the past two weeks differed significantly among the groups ($p=0.02$); sedentees had a significantly greater likelihood of hot flashes during the past two weeks for women who spent a lot of time cooking. However, among the White Londoners, the opposite was true, e.g., 73% of women who fell below the site-specific median cooking time demonstrated at least one objective hot flash compared to 21% of women who were above the median cooking time ($p<0.01$) (**Table 4**). This relationship differed significantly across groups ($p<0.01$). As Table 1 showed, white

Londoners spent significantly less time on housework and cooking compared to the Bangladeshis.

[Table 4 goes about here]

Post-menopausal status remained a significant determinant of subjective hot flashes (OR 7.32, 95% CI 2.11-25.39) in a logistic regression model that included group membership (Bangladeshi migrant, sedentee, white Londoner), time spent cooking (low/high), parity, and BMI. Parity also remained significant in the model (OR 1.61, 95% CI 1.05-2.48); however, group membership, cooking, and BMI were not significant determinants of subjective hot flashes (**Table 5**). Temperature and humidity measures were added separately to the model, but none were significant nor did they have an effect on the other variables in the model.

[Table 5 goes about here.]

The model was repeated with housework (low/high) instead of cooking. Post-menopausal status remained significant; however, parity did not. This may be because parity and housework were positively correlated ($r=0.67$, $p<0.01$), whereas parity was not correlated with cooking ($r=0.13$, $p=0.56$). Women who did more than the median minutes/week of housework were more likely to report a subjective hot flash during the study period compared to women who did less than the median amount of housework (OR 3.24, 95% CI 1.02-10.27) (**Table 5)**. Objective hot flashes were not significantly associated with any of the variables of interest, including menopausal status, temperature, humidity, or time spent cooking or doing housework. In attempting to apply logistic regression models to identify determinants of objective hot flashes, no significant model could be constructed.

Subjective/objective hot flash concordance

During the study time frame of 11:00 to 19:00, sedentees had more subjective (3.0) than objective (1.4) hot flashes. In contrast, Bangladeshi immigrants in London demonstrated slightly more objective (1.8) than subjective hot flashes (1.3). White London neighbors had the same number of objective (1.3) and subjective hot flashes (1.3).

Measures of concordance between subjective hot flash and objective hot flash classification in 20-minute segments were generally very low and similar among the three groups (**Table 6**). Kappa statistics ranged from 1.6% for Bangladeshi immigrants to 3.4% for sedentees. When assessment of agreement was limited only to those 20-segments classified as a hot flash by either approach, results were similar, with no significant differences among groups. Agreement ranged from 10% for Bangladeshi immigrants to 20% for white London neighbors. Estimates of sensitivity were also low in all groups. The proportion of subjective hot flashes that were also classified as objective hot flashes varied little among the groups, and was between 20% and 28%. Similar proportions of objective hot flashes were also self-reported as hot flashes among Bangladeshi sedentees (43%) and white London neighbors (39%), whereas a significantly lower proportion was observed among Banglaheshi immigrants (19%).

[Table 6 goes about here.]

Among women who wore the hot flash monitor and filled out the body diagram, 18 did not indicate hot flashes on the upper chest in the diagram. Only 2 (11%) of those 18 women demonstrated concordance between subjective and objective hot flashes during the study period. Among the 50 women who indicated hot flashes on the upper chest, 16 (32%) demonstrated concordance between subjective and objective hot flashes. The likelihood of concordance between subjective and objective hot flashes did not significantly differ between women who did

and did not indicate hot flashes on their chest (p=0.09); however, the difference may be significant in a larger sample of women.

DISCUSSION

We have compared hot flash experience across different ethnic groups living in very different environments: British women of European ancestry living in London, Bangladeshi immigrants living in London, and Bangladeshi women living in Sylhet, Bangladesh. The two countries differ dramatically in terms of climate, economics, and health resources. Bangladesh is in a sub-tropical zone situated at 23° 46' latitude with three climatic seasons across the year. These comprise a cool, dry winter from October to March, a hot, humid summer running from March to June, and a cooler, rainy season during the Monsoon in June to October. The mean high in January during the winter is 25°C, 35°C in April, and 31°C in August (http://us.worldweatheronline.com/dhaka-weather-averages/bd.aspx). Precipitation and humidity are highest during the Monsoon months. These statistics should be compared to the cool, temperate climate of the UK which has a mean high of 9°C in January, and a mean high of 23°C in July and August. Rainfall remains fairly constant across the year (http://us.worldweatheronline.com/london-weather-averages/city-of-london-greater-london/gb.aspx).

Bangladesh also differs dramatically from the UK in economic terms. The per capita Gross National Income (formerly GNP) of Bangladesh is $1,080 USD compared to a GNI of $43,390 in the UK. In 2011, Bangladesh had 0.4 doctors per 1,000 people, compared to 2.8 in the UK (http://data.worldbank.org/indicator/SH.MED.PHYS.ZS) and life expectancy in Bangladesh is 70 years compared to 81 in the UK (http://data.worldbank.org). Due to the

climate, lack of sanitation and the health infrastructure, Bangladeshis suffer from more infectious and parasitic diseases compared to most British people (Begum et al. 2016; Murphy et al. 2013).

Cultural attitudes towards menopause also differ substantially between the two countries (Sharmeen, 2009). In Bangladesh, many women were unused to talking about the menopause due to its deeply personal nature; 40% of participants admitted not having discussed the topic with anyone previously. Many women viewed the menopausal transition neutrally or as a natural phenomenon associated with aging, citing it as "God' will". They also held deeply cultural and religious views concerning menstruation which is regarded as cleansing the body of bad blood. As a consequence, some women viewed menopause negatively because the body would be storing this bad blood which could lead to ill health. Many explained menopausal symptoms in this light. Some Bangladeshi women also saw positive aspects to menopause in that it increased their ability to participate in Muslim rituals. In contrast, the London women of European origin viewed the menopause more often from a scientific, medical viewpoint and were more negative about its effects (Sharmeen, 2009). They predominantly linked it to a loss of menses, the end of fertility and the beginning of an uncertain period of change, although some were more positive about these aspects. Their attitudes may reflect the predominant western model which has medicalized the menopausal transition and postmenopausal life.

One may be tempted to think, in light of the everyday difficulties that accompany life in Bangladesh, that women may not notice their hot flashes. The results of this study, however, suggest that this assumption is false. Across the three groups, the frequency of <u>ever</u> having experienced hot flashes was about the same (67%, 68%, and 72%), as was the report of hot flashes (yes/no) during the past two weeks ($p=0.27$). Bangladeshi sedentees tended to be more likely to describe "extreme" hot flashes ($p=0.09$) and report hot flashes more frequently ($p=0.07$)

compared to white Londoners. During the study period, sedentees reported more subjective hot flashes ($p<0.05$). In other words, Bangladeshi women living in Bangladesh were just as likely, or more likely, to report hot flashes compared to women of European origin in London.

In addition, the description of hot flashes in Bangladesh did not differ from descriptions in London. When asked to choose from a closed-choice list of adjectives, women's choices did not vary across the three groups with the exception of "burning sensation" which was selected more often by Bangladeshi women in both study sites. In Bangladesh, women described hot flashes as *gorom vap laga* (feeling steaming hot), *gorom faap laga* (feeing uncomfortably hot inside, queasy, or suffocating), *akhta gorom laga* (a sudden feeling of heat), or *matha dia dhuma jai* (smoke coming from the head) (Sievert et al. 2008). This last description is consistent, perhaps, with the choice of "burning sensation" from the closed-choice list of hot flash descriptors.

Exactly where hot flashes were experienced on the body differed, but this may be explained by cultural differences in clothing. It appears that hot flashes are sensed where skin is exposed. For example, 71% of white London neighbors described hot flashes on the front of their neck in contrast to only 32% in Bangladesh ($p<0.05$). The front of the neck would never be exposed in Bangladesh, where women wear a scarf across their chest and neck, as written in the Qur'an (024:031, "And tell the believing women to lower their gaze and be modest, and to display of their adornment only that which is apparent, and to draw their veils over their bosoms" http://www.usc.edu/org/cmje/). In contrast, white Londoners often expose the front of their neck with sweaters, blouses or t-shirts. On the other hand, women who wear saris often expose part of their back, and feet are more often exposed in Bangladesh than in Britain because women can wear sandals year round. Hot flashes were more often felt on the back by Bangladeshis in both

sites ($p<0.05$), and on the feet in Bangladesh ($p<0.05$). Perhaps hot flashes are felt where sweating and evaporation can most easily occur.

Temperatures on the days of hot flash monitoring were significantly higher in Sylhet than in London; however, there was within-site variation as well. Women in London were monitored during both winter and summer; at 12:00, temperatures in London ranged from -3 to 25.3°C and humidity ranged from 47% to 97% across the year. Women in Bangladesh were monitored during March and April; at 12:00, temperatures in Sylhet ranged from 23 to 32°C and humidity ranged from 28% to 83%. Hot flash monitors were worn from 11:00 to 19:00, the hottest part of the day. Households in Bangladesh were highly unlikely to have any form of air conditioning which was limited to a few public places like banks. In contrast, households in London were more than likely to have some form of household heating during winter.

We had hypothesized a greater likelihood of *subjective*, self-reported hot flashes in association with the temperate climate of London, and a greater likelihood of *objective* hot flashes in Sylhet, Bangladesh, but neither hypothesis was supported by the data. The self-reported frequency of hot flashes (e.g., 1/day or 1/week) was positively correlated with temperature at 12:00, consistent with the results of Hunter et al. (2013), but temperature was not associated with subjective or objective hot flashes in any multivariate analysis.

We had expected a greater likelihood of hot flashes with greater activity; however, for the entire sample, there were no significant relationships between exercise (yes/no), time spent in housework (min/week), or time spent cooking (min/week) and the occurrence of subjective or objective hot flashes during the study period. When we examined subgroups, sedentees demonstrated a greater likelihood of hot flashes during the past two weeks in relation to more time spent cooking. This may be because Bangladeshis cook in small kitchens, often with no

windows, over the open-flame of a propane burner. Among white Londoners, the relationship between hot flashes and cooking was reversed. This may be because white Londoners spent significantly less time on housework and cooking compared to the Bangladeshis. Moreover, white London neighbors were significantly more likely to exercise (80% vs. 27% of sedentees) and may have been more physically fit. If white Londoners were more physically fit, then cooking and housework would not present the same degree of exertion as it would for the Bangladeshis. Other studies have suggested that women with a higher level of fitness before menopause are less likely to report hot flashes (Guthrie et al. 2005; Ivarsson et al. 1998).
For the entire sample, time spent on housework was a significant determinant of subjective hot flashes during the study period after controlling for group membership, menopausal status, parity, and BMI. This is consistent with findings limited to just Sylhet, Bangladesh, where both housework and cooking were significant determinants of hot flashes (Sharmeen et al. 2013). Finally, we had hypothesized a higher level of concordance between objective and subjective measures of hot flashes in the temperate climate of London compared to the tropical climate of Sylhet. There was a slightly higher rate of concordance among white Londoners compared to Bangladeshi immigrants and sedentees (20% vs. 10% and 16%, respectively); however, the rate of concordance among white Londoners was only 2.6% above what would be expected by chance.

Measures of concordance were very low, with percent agreement between the subjective and objective measures only 1.6% to 3.4% beyond that expected by chance alone. Concordance between subjective and objective hot flashes ranged from 10% among Bangladeshi immigrants to 20% among white London neighbors (Table 6). Sedentees reported 43% of the hot flashes they demonstrated, and white London neighbors reported 39% of the hot flashes they

demonstrated. This level of sensitivity is similar to the levels of 34 to 46% reported by Carpenter et al. (2004).

In contrast, Bangladeshi immigrants reported only 16% of the hot flashes they demonstrated. This is consistent with the findings in Bangladesh where only 14% of Muslim women reported a hot flash that they demonstrated (Sievert et al. 2008). All of the Bangladeshi migrants to London were Muslim, suggesting that the clothing or religious practices that may have contributed to the lack of hot flash report in Sylhet were the same in London. Immigrants may be more likely to carry out Islamic practices in London, compared to Sylhet, because the practices serve as markers of ethnic identity in a new country. Another point for consideration is that Bangladeshi sedentees and white London neighbors are living in the climate in which they grew up. Bangladeshi immigrants have changed climates, from hot tropical to cool temperate, and for some reason immigrants may not feel or interpret as notable the internal heat associated with hot flashes. In addition, the placement of the electrodes in the upper chest could influence discordance between subjective and objective hot flashes for some women.

Although the rate of concordance in this study is low, the use of sternal skin conductance to detect hot flashes has several advantages. For example, the measure does not rely upon the subjective reporting of hot flashes which can be influenced by emotions, physical state, adherence to reporting, and wake/sleep cycles (Fisher and Thurston, in press). Subjective and objective hot flashes may indicate different phenomena (Fisher and Thurston, in press; Sievert 2013). For example, objective hot flashes may be a better marker of cardiovascular risk (Brown et al. 2011).

A similar study design was carried out by Gupta et al. (2006) among women living in Delhi, India, and women of Indian and European ancestry living in Birmingham, UK. All

women were peri- or postmenopausal women and aged 45 to 55 (n=153). Only 32% of women in Delhi reported hot flashes during the past two weeks compared to 75% of the UK Asian women and 61% of the women of European origin living in Birmingham. In the results reported here, 73% of Bangladeshis reported hot flashes during the past two weeks in Sylhet, compared to 63% of Bangladeshis in London and 55% of women of European origin living in London. Compared to the study by Gupta et al. (2006), white women in the UK have a similar hot flash frequency during the past two weeks (55% vs. 61%), and Bangladeshi women in London are not too different from Indian women in Birmingham (63% vs. 75%); however, Bangladeshi women in Bangladesh are much more likely to report hot flashes compared to Indian women in Delhi (73% vs. 32%). This may be due to genetic, cultural, or lifestyle differences.

The finding that pre-menopausal women were less likely to report hot flashes during the study period compared to peri- and post-menopausal women is consistent with the literature (Gold et al. 2006). Women with subjective hot flashes had more children compared to women without hot flashes (3.6 vs. 2.8 children, $p<0.05$), perhaps because more children increase the amount of physical activity related to housework.

In this study we were able to test for differences in climate, but we did not have detailed information about the extent to which women might use indoor climate control to assist with maintaining body temperatures. Neither in England nor Bangladesh, however, is household air-conditioning the norm. Households in London would be more than likely to have some form of indoor heating during the winter. We were also unable to examine differences in the cultural interpretation of experience, or cultural differences in willingness to report symptoms (Brown et al. 2009; Mann and Hunter 2011).

Other limitations include small sample sizes and the relatively short length of time the monitors were worn (an average of 9.9 hours). Although a few women wore the monitors overnight to satisfy their own curiosity, we made the decision to ask women to wear the monitors from late morning to early evening for two reasons. First, we had to negotiate the cultural fact that many Bangladeshi women had to ask for their husband's permission to participate in the study. We were worried that husbands would be less likely to grant permission if their wives wore a hot flash monitor at night. Secondly, we chose those times because that is when hot flashes peak in 24-hour studies of hot flashes (Carpenter et al. 2001; Freedman et al. 1995; Sievert et al. 2010). As a result of our study design, we may have missed recording night sweats from the 7 women who reported night sweats but not hot flashes on the questionnaire. Because we used just one pair of electrodes on the upper chest, we may have missed documenting objective hot flashes on other parts of the body. Finally, another limitation of this study is that cooking and activity measures refer to the week prior to interview. Women were not asked to keep activity diaries while they wore the hot flash monitors.

Strengths of this study include the high degree of comparability across study sites. The same questions were asked in the same way by the same set of investigators in both London and Bangladesh. In addition, ambient temperature and humidity measures were available for the exact days on which hot flashes were measured in Bangladesh, and for most of the days on which hot flashes were measured in London.

CONCLUSIONS

Across the three groups, the frequency of having experienced hot flashes ever and during the past two weeks was about the same, but sedentees reported more subjective hot flashes

during the study period ($p<0.05$). Although the adjectives chosen to describe hot flashes did not differ across the groups (with the exception of a "burning sensation" among Bangladeshis), there were differences in how hot flashes were described on the body. White London neighbors were significantly more likely to describe hot flashes on their face and the front of their neck, and less likely to describe hot flashes on their back and feet, compared to Bangladeshi women. These differences may reflect variation in sweating patterns (Sievert 2007), variation in clothing, or variation in awareness of sweating.

Post-menopausal status, increasing parity, and high levels of housework were significant determinants of subjective hot flashes. Ambient temperature and humidity were not significant determinants of either subjectively reported, or objectively demonstrated, hot flash measures. Low levels of concordance between subjective and objective hot flashes were measured across the groups. Similar proportions of objective hot flashes were also self-reported as hot flashes among Bangladeshi sedentees (43%) and white London neighbors (39%), but a lower proportion was observed among Bangladeshi immigrants (19%).

In summary, our hypotheses were not fully supported. Hot flashes were associated with housework and site-specific patterns of cooking during the past week, but were not associated with warmer temperatures on the days that monitors were worn. The levels of concordance between objective and subjective hot flash measures were not significantly greater among white Londoners.

ACKNOWLEDGMENTS

This study was supported by an NSF grant #0548393, a Commonwealth Scholarship and Fellowship Plan (CSFP, UK), Sigma Xi, and the Wolfson Research Institute, Durham

University. We thank R. Barry Hall, Climate Enquiry Officer of the Central Climate Unit, Met Office, UK, for his help in finding the temperatures and humidity in London and Bangladesh on the days of hot flash monitoring. We are also thankful for the help of Fabiola del Castillo, Susmita Paul Jamy, Sunali Biswas, Nusrath Jahan, Mahbuba Bari Shikder, Shamima Begum, Sayema Islam Shetu, Sufia Sultana, Rumana Begum, Kanij Fathema, Salma Begum, Khaza Nazim Uddin, Tamanna Sultana, Eva Goldwater, and for the generous help of the study participants in London and Sylhet, Bangladesh. We thank the Institute of Advanced Study, Durham University, for the opportunity to finish this manuscript.

Author contributions

LLS, GRB, and BWW carried out the analyses and wrote the paper, while KB, TS, and LM carried out most of the interviews and contributed to analyses. LLS, GRB, and SM designed the study, with the help of OC in Bangladesh.

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FIGURE LEGEND

Figure 1: Where women who reported hot flashes feel hot flashes. **Bangladeshi sedentees n=22 (bold, red);** Bangladeshi migrants n=25 (underlined); White neighbors (blue) n=21. *$p<0.05$

Table 1: Characteristics for the entire sample (n=534) and for those who wore the hot flash monitor (n=95) together with ambient temperature and humidity on the days when hot flash monitors were worn (n=85).

		Subset of women who wore the hot flash monitor			
	Entire sample (n=534)	All who wore the monitor (n=95)	Bangladeshis in Sylhet, Bangladesh (n=30)	Bangaldeshi immigrants in London (n=35)	White London neighbors (n=30)
Age at interview years (s.d.)	46.3 (7.2)	47.4 (5.4)	47.3 (4.2)	45.8 (5.1)	50.2 (5.9) **
Years education (s.d.)	10.2 (4.0)	10.2 (3.6)	9.6 (3.4)	8.1 (2.9)	12.8 (2.8) **
Religion					
Muslim	64%	59%	73%	100%	Not asked
Hindu	6%	8%	27%	0%	
Not asked	30%	33%	0%	0%	
Marital status					
Single	13%	11%	0%	3%	33%
Married	66%	69%	80%	77%	44%
Co-habiting	3%	4%	0%	0%	15%
Widowed	10%	12%	17%	17%	0%
Divorced	8%	4%	3%	0%	7%**
Parity (s.d.)	2.8 (1.9)	3.2 (1.7)	3.7 (1.6)	3.9 (1.2)	2.6 (5.6)
Menopause status					
pre-	59%	48%	37%	66%	35%
peri-	7%	12%	13%	11%	14%
post	34%	40%	50%	23%	52%
Percent chew betel nut	37%	37%	53%	57%	Not asked
Percent who smoke	10%	6%	0%	0%	21%
Percent who exercise	46%	49%	27%	43%	80%**
Time spent on housework (min/week) (s.d.)	261 (523)	244 (318)	396 (457)	209 (194)	121 (88)**
Time spent	705 (744)	618 (463)	882 (531)	663 (396)	303 (223)**

cooking (min/week) (s.d.)					
BMI kg/m^2 (s.d.)	26.5 (4.1)	26.6 (4.4)	25.8 (4.0)	27.4 (2.8)	26.3 (5.3)
Waist circumference cm (s.d.)	85.7 (10.9)	85.2 (11.8)	87.0 (12.4)	87.8 (2.8)	80.1 (13.1) *
Hours hot flash monitor was worn		9.9	10.8	9.1	10.1
Mean ambient temperatures °C when monitors were worn		n=85	n=23	n=32	n=30
12:00		18.9 (8.5)	28.4 (2.7)	18.6 (4.3)	12.5 (8.5) **
18:00		17.0 (7.2)	22.7 (2.2)	17.7 (4.6)	11.7 (8.3) **
Mean ambient humidities % when monitors were worn					
12:00		61.2 (16.7)	45.3 (13.8)	66.4 (14.2)	67.1 (13.8) **
18:00		72.2 (13.8)	73.8 (13.2)	71.9 (15.6)	71.1 (12.5)

** $p<0.01$, comparison across the three study groups

Table 2: Report of hot flashes and night sweats during the past two weeks, hot flashes ever, and (among women with hot flashes) frequency of hot flashes and characteristics of hot flashes.

		Subset of women who wore the hot flash monitor			
	Entire sample (n=534)	All who wore the monitor (n=95)	Bangladeshis in Sylhet, Bangladesh (n=30)	Bangladeshi immigrants in London (n=35)	White London neighbors (n=30)
Hot flashes in past 2 weeks					
None	62%	36%	27%	37%	45%
A little	18%	21%	23%	11%	31%
Quite a bit	13%	22%	27%	20%	21%
Extreme	7%	20%	23%	31%	3%
Ever had hot flashes	46%	69%	67%	68%	72%
Hot flash frequency	N=261	N=68	N=22	N=25	N=21
<1/mon	24%	7%	0%	4%	27%
1-2/mon	29%	13%	18%	29%	9%
1-4/week	24%	19%	32%	29%	23%
1-4/day	16%	17%	27%	17%	32%
>5/day	7%	12%	23%	21%	9%
Hot flash characteristics[a]					
Burning	56%	59%	73%	68%	33%*

[a]In addition, there were no significant differences across the three groups for feeling heat, flushing, sweating, pressure in head, pressure in chest, change in heart rate, change in breathing, anxiety, embarrassed, chills, feeling ill/nauseous, feeling depressed, or feeling suicidal during a hot flash.

*$p<0.05$

Table 3: Number of subjective and objective hot flashes from 11:00 to 19:00

	Sedentees N=30	Migrants N=35	White neighbors N=30
Number of subjective hot flashes during study period	Range 0-11 3.0 (s.d. 3.4)	Range 0-12 1.3 (s.d. 2.4)	Range 0-8 1.2 (s.d. 1.9)*
Percent who had a least one subjective hot flash	63%	40%	47%
Among women who had at least one subjective hot flash: number of subjective hot flashes	N=19 Range 1-11 4.7 (s.d. 3.2)	N=14 Range 1-12 3.1 (s.d. 3.0)	N=14 Range 1-8 2.6 (s.d. 2.1)
Number of objective hot flashes during study period	Range 0-9 1.4 (s.d. 2.7)	Range 0-12 1.8 (s.d. 3.1)	Range 0-5 1.3 (s.d. 1.7)
Percent who had at least one objective hot flash	33%	49%	50%
Among women who had at least one objective hot flash: number of objective hot flashes	N=10 Range 1-9 4.1 (s.d. 3.3)	N=17 Range 1-12 3.7 (s.d. 3.6)	N=15 Range 1-5 2.6 (s.d. 1.5)

*$p<0.05$

Table 4: Hot flashes in relation to low/high minutes per week spent in housework and cooking (cutoffs at sample-specific medians)

	Housework low	**Housework high**	**Cooking low**	**Cooking high**
Total sample	< 138 min/week	> 138 min/week	<500 min/week	>500 min/week
N	39	39	43	48
Subjective hot flash during study period	44%	63%	51%	48%
Objective hot flash during study period	36%	45%	51%	35%
Hot flashes during past two weeks	56%	72%	58%	68%
Sedentees	<280 min/week	>280 min/week	<800 min/week	>800 min/week
N	14	14	9	20[a]
Subjective hot flash during study period	50%	71%	44%	75%
Objective hot flash during study period	29%	36%	11%	45%
Hot flashes during past two weeks	64%	79%	**44%**	**90%****
Migrants	<150 min/week	>150 min/week	<800 min/week	>800 min/week
N	10	10	16	17
Subjective hot flash during study period	40%	60%	56%	24%
Objective hot flash during study period	30%	50%	44%	47%
Hot flashes during past two weeks	60%	70%	69%	53%
White London neighbors	<103	>103	<220	>220
N	14	15	15	14
Subjective hot flash during study period	57%	40%	60%	29%
Objective hot flash during study period	64%	33%	**73%**	**21%****
Hot flashes during past two weeks	56%	54%	54%	50%

[a] Even sample sizes not possible because of data clustering.

** $p<0.01$

Table 5: Results of logistic regressions for subjective hot flashes during the study period (11:00 to 18:00), model 1 with time spent cooking, model 2 with time spent on housework:

Model 1, n=84	OR	95% CI
Group		
Migrant (Ref)		
White London neighbors	0.950	0.170-5.311
Sedentees	2.961	0.862-10.170
Menopausal status		
Pre- (Ref)		
Peri-	1.698	0.347-8.305
Post-	7.319	2.110-25.392
Cooking time		
Low (Ref)		
High	0.455	0.139-1.487
Parity	1.611	1.046-2.480
BMI	1.035	0.920-1.164
Model 2, N=69		
Group		
Migrant (Ref)		
White London neighbors	0.750	0.114-4.927
Sedentees	1.071	0.276-4.151
Menopausal status		
Pre- (Ref)		
Peri-	3.162	0.496-20.169
Post-	7.102	1.713-29.438
Housework time		
Low (Ref)		
High	3.239	1.022-10.265
Parity	1.472	0.963-2.250
BMI	1.055	0.925-1.202

Addition of humidity and temperature variables did not affect results. None of the humidity or temperatures measurements was significant.

Table 6: Classification of 20-minute segments as having subjective hot flashes and objective hot flashes, measures of agreement and measures of sensitivity and 95% confidence intervals comparing classification of subjective and objective hot flash. No limit for time of day.

	Hot flash frequencies			Measures of concordance		Measures of sensitivity[b]	
Group	Objective HFs	Subjective HFs		Kappa	Agreement on presence of HFs[a]	Objective HF (Gold std. = subj. HF)	Subjective HF (Gold std. = obj. HF)
		Yes	*No*				
Bangladeshi sedentees (n=30)	*Yes*	19	25	0.034	0.16 (0.10, 0.23)	0.21 (0.14, 0.29)	0.43 (0.34, 0.52)
	No	71	845				
Bangladeshi migrants (n=35)	*Yes*	9	47	0.016	0.10 (0.04, 0.16)	0.20 (0.12, 0.29)	0.16 (0.08, 0.24)
	No	35	707				
White London neighbors (n=30)	*Yes*	13	20	0.026	0.20 (0.10, 0.29)	0.28 (0.17, 0.39)	0.39 (0.28, 0.51)
	No	33	844				

[a] Agreement on presence was calculated as the proportion of all subjective and/or objective hot flashes that were classified as a hot flash by both methods. For example, among Bangladeshi migrants, 10% of all hot flashes (95% confidence interval: 4%-16%) were classified as hot flashes by both approaches.

[b] Sensitivity was calculated as the proportion of the gold standard hot flashes that were also classified as hot flashes by the non-gold standard approach. For example, among white London neighbors, 28% of all self-reported hot flashes were also classified as objective hot flashes, and 39% of objective hot flashes were also self-reported as hot flashes.

Figure 1: Where, on the body, women who reported hot flashes feel hot flashes.
Bangladeshi sedentees n=22; Bangladeshi migrants n=25; White neighbors n=21. *p<0.05